The Mole-Bean Lab - Understanding the Mole

Purpose
To better understand the mole system and the table of atomic masses by comparison with a model system.

Discussion
The relative mass of particles is actually how many times heavier the object is compared to the lightest particle. The atomic masses of the atoms are all relative masses. They are relative to the lightest element, which is hydrogen. Carbon, which has a relative mass of 12, is 12 times heavier than hydrogen, etc. In this lab, you will be dealing with the relative mass of beans and then drawing a parallel to the atomic masses of the elements.

Apparatus Needed
For each group:

1) 4 different types of beans with enough difference in size and weight. Each group will need at least 100 of each type of bean.
2) Plastic trays to hold the beans
3) Balance

Chemicals Needed
One mole of each of the following substances somewhere in the room. These substances should be in powdered, granular, or liquid form:

- Sucrose ($C_{12}H_{22}O_{11}$)
- $CuSO_4$
- Al
- S
- Zn
- Cu
- Water

Procedure
1a) Zero your plastic trays. Count out exactly 100 beans of one type and place them on your tray, discarding any beans which differ greatly from an average bean. This is important because if you do not do this, your results will not be accurate.

1b) Repeat this procedure for each type of bean provided.

2a) Calculate (DO NOT WEIGH) the mass of one bean of each type and record it in the data table**. CALCULATE means take the total weight of 100 beans and divide it by 100 rather than just weighing one bean.**

2b) Determine the relative mass of each type of bean by comparison to the lightest type of bean.

$$\textit{Relative mass} = \frac{\textit{Average Mass of Bean}}{\textit{Average Mass of Lightest Bean}}$$

$$\textit{No. of Beans in Relative Mass} = \frac{\textit{Relative Mass}}{\textit{Average Mass of One Bean}}$$

Weigh out (do not calculate) the relative mass (in grams) of each kind of bean and count the beans weighed. Do not throw away your relative mass piles of beans because you will be asked questions about them later.

Data Table

	Bean 1	**Bean 2**	**Bean 3**	**Bean 4**
Type of Bean				
Mass of Beans (g)				
Av. Mass of One Bean (g)				
Relative Mass (g)				
No. of Beans in Relative Mass				

Part II

Below is a chart with the weights of individual atoms. These weights are actually calculated. Figure out the relative masses and put them on the chart. Also, figure out the number of atoms in the relative mass and put this in the third column.

Atom	**Mass of One Atom in (g)**	**Relative Mass in (g)**	**Number of Atoms in the Relative Mass (This should be calculated.)**
Hydrogen	1.66×10^{-24}		
Sulfur	5.31×10^{-23}		
Iron	9.30×10^{-23}		
Aluminum	4.49×10^{-23}		
Zinc	1.08×10^{-22}		
Lead	3.44×10^{-22}		
Copper	1.05×10^{-22}		

Part III

Look at the moles around the room to answer this section.

Mole	**Volume of One Mole**	**Mass of One Mole**	**Smallest Particle** (Atom/Molecule)**
Sucrose ($C_{12}H_{22}O_{11}$)			
$CuSO_4$			
Al			
S			
Zn			
Cu			
Water (H_2O)			

***Smallest particle means the smallest unit that makes up the matter.

Thought Questions for Part I
Refer to your data from Part I to answer the following questions:

1) What did you find out about the number of beans in the relative mass?

2) Compare the volume of the relative mass piles. Are they the same? Why or why not?

3) Compare the masses of the relative mass piles of beans. Are they the same? Why or why not?

4) What is the relative mass of the lightest bean?

5) Hydrogen is the lightest element and weighs 1.66×10^{-24} grams. Very small, yes, because we are dealing with one atom. What is the relative mass of hydrogen if it is the lightest element?

Thought Questions for Part II
Refer to your data from Part II to answer the following questions:

6) Now look at the atomic weights of the elements listed in Part II. Comment.

7) What are the atomic weights and how were they determined?

8) What do you know about the number of atoms in a relative mass of atoms?

9) How many atoms are there in an atomic weight of any atom if the unit is grams? Remember that this number was not really known for many years. The actual number is not important, but what is important is that it was always known that in the same relative masses you have the same number.

Thought Questions for Part III
Refer to your chart on Part III while answering this part:

10) Which mole had particles that occupied the largest volume? The smallest volume?

11) Which mole weighed the most? _____ Which mole had the heaviest individual particles?_____ Why do the two questions above have very logical answers?

12) Why do the moles of elements or compounds weigh differently if they all contain the same number of particles?

13) Why do moles of elements or compounds occupy differing volumes?